DOCUMENT RESUME

ED 208 040 TM 810 737

AUTHOR Kulik, James A.
TITLE Integrating Findings from Different Levels of Instruction.
SPONS AGENCY National Science Foundation, Washington, D.C.
PUB DATE Apr 81
GRANT SED-79-20742
NOTE 18p.; Paper presented at the Annual Meeting of the American Educational Research Association (65th, Los Angeles, CA, April 13-17, 1981).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Aptitude Treatment Interaction; Elementary Secondary Education; Higher Education; Individual Instruction; Mathematics Instruction; *Research Methodology; Research Needs
IDENTIFIERS *Meta Analysis

ABSTRACT

The type of study proposed by Cronback for studying aptitude-treatment interactions (ATIs) has proved to be disappointing in several respects: it produces ATIs that do not replicate, that are not especially interesting, and that are difficult to use in practice. Glass's meta-analysis methodology, although developed for a different purpose, sometimes yields information about ATIs: about which treatments are especially effective for certain types of learners. This point is illustrated by a survey of research on individual instruction in mathematics. It is recommended that meta-analysis be used more as a means of investigating ATIs because the results seem to be replicable, stimulating from the standpoint of instructional theory, and have clear implications for practice. (Author/BW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED208040

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Integrating Findings from Different Levels of Instruction

James A. Kulik

Center for Research on Learning and Teaching

The University of Michigan

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

J. A. Kulik

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

A Symposium Paper Presented at the Annual Meeting

Of the American Educational Research Association

Los Angeles, April, 1981

TM 810 737

The main point I will try to make this morning is that individualized instruction has different effects on different people. Specifically, I will argue that it has different effects on elementary school, secondary school, and college-level learners. I will be arguing therefore for the existence of an Aptitude-by-Treatment interaction involving the developmental level of the learner and the degree of individualization. Before I present my argument and the evidence for it, however, I want to make some general points about Aptitude-by-Treatment interactions in education.

Cronbach's Contribution

I believe that Cronbach's call for a science of Aptitude-by Treatment interactions (or ATIs) in 1957 was one of the most exciting challenges made to psychology and education in recent years. In his 1957 address, Cronbach contended that behavioral researchers were split into two opposing camps by two opposing traditions. One tradition was basically aristocratic and conservative, and emphasized the stable differences among people. This was the measurement or psychometric tradition that traced its lineage back to nineteenth century Britain and to the contributions of Francis Galton. A second tradition was more democratic and optimistic, and emphasized the malleability of people and their capacity to profit from experience. This was the tradition of behaviorism developed in America under the leadership of Edward Thorndike and John Watson. Cronbach held that the split between the correlators and the manipulators impeded scientific research.

The type of study that was to heal the split combined the correlating and the manipulating approaches. The typical study was a two-group experiment in which aptitude was measured for each subject in each group. An ATI existed when one treatment was not <u>equally</u> superior (or inferior) to another treatment all long the aptitude scale. Treatment A, for example, might help students of high ability quite a bit, but might be no better than Treatment B for students of low ability. The signal that an ATI existed was a difference in the regression of outcome on aptitude for the two groups.

In the 60's and 70's, the potential of this type of experiment seemed great for both educational research and practice, but today it is a commonplace observation that the yield of ATI studies has been disappointing in several ways:

--First, it would be nice if ATI studies replicated, but ATIs found in one setting rarely turn up in other settings. The lack of replicated ATIs has been one of the biggest single disappointments in the ATI literature.

--Second, it would be nice to have <u>specific</u> abilities consistently involved in ATIs. That would add greatly to our theoretical knowledge of ability. But ATIs, when they are found, often involve <u>general</u> aptitude. Theoretically stimulating findings have been the exception rather than the rule in ATI research.

--Third, it is now also clear that early ideas about ATIs were also simplistic from a pedagogical point of view. Suppose that nonvisualizers do not learn well from diagrams, while visualizers do. Should we therefore condemn nonvisualizers forever to prose explanations? Perhaps nonvisualizers need more work, rather than less, with diagrams. Educators have been protected from thinking through the pedagogical implications of ATIs only because ATIs have been so rarely confirmed.

Glass's Approach

Let me turn now to Glass's (1976) work on meta-analysis. This work was not originally designed to shed light on ATIs. Glass's concern was simply to find a way to make sense of the rapidly growing literature of education and psychology. His solution was to treat study results as though they were raw data from an experiment. He used systematic methods to collect studies; he used objective techniques to quantify variables; and he used statistical methods to analyze the collected results.

A careful look at the conclusions from meta-analysis shows that they sometimes involve ATIs. Meta-analytic conclusions tend to be of two types. The first type of conclusion is about overall or main effects--the average effect of a treatment in a set of studies. The other conclusions from meta-analysis are about interaction effects--the special conditions that modify the general conclusions. Thus, Glass tried to determine not only how effective psychotherapy was in general, but also whether psychotherapy was especially effective in studies of certain types of patients. When meta-analysis establishes special effectiveness for a method in studies of a certain type of person, meta-analysis is--in effect--positing an ATI.

I believe that in the long run we will learn a good deal about ATIs from meta-analysis. That is, to find out which treatments are most effective for which people, we should not only look within studies (as Cronbach does), we should also look across collections of studies (as Glass has done). If we use this strategy, I think that we will overcome the shortcomings of traditional ATI research. First, we'll get consistent results; second, we'll get stimulating results; and third, we'll get results that we can use.

Results

First, let me say something about the consistency of results from meta-analysis. This symposium gives us a rare opportunity to check on the consistency of meta-analytic findings because its analyses overlap in part with analyses carried out a few years ago by Susan Hartley, one of Glass's students. In 1977 Hartley wrote her dissertation reporting on meta-analytic findings on individually paced instruction in mathematics. Included in her results were findings on tutoring programs and programmed instruction. Although Pete Cohen's (1981) and Barb Ebeling's (1981) analyses covered more than mathematics

instruction, it is possible to look separately at their results from the area of mathematics, and to check these results against Hartley's.

+--------------------------------+
| Insert Figure 1 about here |
+--------------------------------+

This figure includes results from the University of Michigan and from the University of Colorado on the effects of tutoring and programmed instruction on mathematics achievement. Both the Michigan and Colorado meta-analyses found that tutoring raised mathematics achievement by .60 standard-deviation-units in elementary and secondary schools. The Colorado meta-analysis reported that programmed instruction boosted mathematics achievement by .01 standard-deviation-units, while the Michigan study found that it decreased mathematics achievement by this amount. I'm impressed by this consistency in results.

+--------------------------------+
| Insert Figure 2 about here |
+--------------------------------+

There is also consistency in the kinds of interactions being reported by different investigators. Three independent meta-analyses have concluded that programmed instruction has been producing better results in recent years than it did in earlier years. This figure shows results from Hartley's meta-analysis at the University of Colorado, and two of our meta-analyses at Michigan. The time trend in results from programmed instruction was a major finding in each of these meta-analyses, and it is a trend that is holding up beautifully as more data are coming in.

+--------------------------------+
| Insert Figure 3 about here |
+--------------------------------+

This figure provides my final example of the consistency in results from meta-analytic studies. Each of the presenters this morning reported that findings published in journal articles were stronger and more positive than findings from dissertations. For the three meta-analyses described this morning, the average effect reported in journal articles was .16 standard-deviation-units higher than the average effect reported in dissertations. In a chapter in a volume edited by Herbert Walberg, Mary Lee Smith (1980) recently summarized findings on this question from University of Colorado studies. Each of 12 Colorado meta-analyses reported that effects in journals were stronger than those in dissertations. In the 12 studies, the average journal effect was .16 standard-deviation-units higher than the average dissertation effect--the same as our result at Michigan.

A second point that I want to make is that meta-analytic findings will often be stimulating because they are based on a wide variety of settings, ages, and groups. To make the point, I will present some

composite results, based on studies from both Michigan and Colorado, on the effects of individualization at different age levels. The results are restricted to mathematics education because that is the only area where meta-analytic studies cover the whole age range--from K through college.

+------------------------------+
| Insert Figure 4 about here |
+------------------------------+

The first figure shows the effects of computer-based individualization on mathematics achievement at different educational levels. I think that the trend is clear. In the elementary schools, individualization has positive effects. Computer drill-and-practice in arithmetic apparently keeps children interested and actively responding; it provides them with immediate feedback on their answers; it guides them from one kind of problem to another. Students and tasks are different at the secondary school level, however, and the relative advantage of the computer begins to fall off. Finally, at the college level, where students are selected for their ability and motivation, computers apparently offer little beyond what can be provided by a teacher, a book, and paper and pencils.

+------------------------------+
| Insert Figure 5 about here |
+------------------------------+

Meta-analytic findings are quite different for self-paced unit approaches to teaching. Methods like IPI, PLAN, and Keller's PSI first divide the subject matter of a class into units that typically cover about a chapter of a textbook or about a week's work. Students use learning activity packages to master the objectives for a unit, and then must demonstrate their mastery of objectives on repeatable quizzes. The meta-analytic results suggest that college students often have the maturity to work under the conditions that these systems provide. College students apparently profit from working themselves for a week or so before receiving an individual evaluation and a prescription for further work. For elementary school students, on the other hand, the systems developed so far may provide too little support. Elementary school pupils may need more feedback, more individual contact, and more guidance than these self-paced systems provide. At this level, computers may be a better investment.

The final point that I want to make is that ATI findings such as those I've reviewed from meta-analytic research seem to have implications for practice. What meta-analysis has shown is that computers and individualized systems have compiled especially strong records in some of the settings where they have been introduced, and have weaker records in other areas. I would encourage more vigorous development of these approaches in the areas where they seem to be making the most substantial contributions.

Let me summarize the points that I have made and the conclusions that I have drawn:

(1) I pointed out that the type of study proposed by Cronbach for investigating ATIs has proved to be disappointing in several respects. This type of study produces ATIs that do not replicate, that are not especially interesting, and that are difficult to use in practice.

(2) I pointed out that Glass's meta-analytic methodology, although developed for a different purpose, sometimes yields information about ATIs--about which treatments are especially effective for certain types of learners.

(3) I recommended that Glass's methodology be used more as a means of investigating ATIs. Results produced by mete-analysis so far seem to be replicable. They seem to me to be stimulating from the standpoint of instructional theory. And they sometimes have clear implications for practice.

References

Cohen, P. A. Educational outcomes of tutoring: A meta-analysis of evaluation findings. A symposium paper presented at the meeting of the American Educational Research Association, Los Angeles, April 1981.

Cronbach, L. J. The two disciplines of scientific psychology. American Psychologist, 1957, 12, 671-684.

Ebeling, B. J. A meta-analysis of programmed instruction in grades 7 - 12. A symposium paper presented at the meeting of the American Educational Research Association, Los Angeles, April 1981.

Glass, G. V. Primary, secondary, and meta-analysis of research. Educational Researcher, 1976, 5, 3-8.

Hartley, S. S. Meta-analysis of the effects of individually paced instruction in mathematics (Doctoral dissertation, University of Colorado, 1977). Dissertation Abstracts International, 1977, 38(7-A), 4003. (University Microfilms No. 77-29, 926)

Smith, M. L. Publication bias and meta-analysis. Evaluation in Education: An International Review Series, 1980, 4(1), 22-24.

Note

The material in this report is based upon work supported by the National Science Foundation under Grant No. SED 79-20742. Any opinions, findings, and conclusions or recommendations expressed in this report are those of the author and do not necessarily reflect the views of the National Science Foundation.

Figure Captions

Figure 1. Average effects of tutoring and of programmed instruction reported in research syntheses carried out at the University of Michigan and at the University of Colorado.

Figure 2. Average effects of programmed instruction in early and recent studies at three different educational levels.

Figure 3. Average size of effect calculated separately by various investigators for studies in journals and in dissertations.

Figure 4. Average effects of computer-based instruction on mathematics achievement at three different educational levels.

Figure 5. Average effects of self-paced instruction on mathematics achievement at three different educational levels.

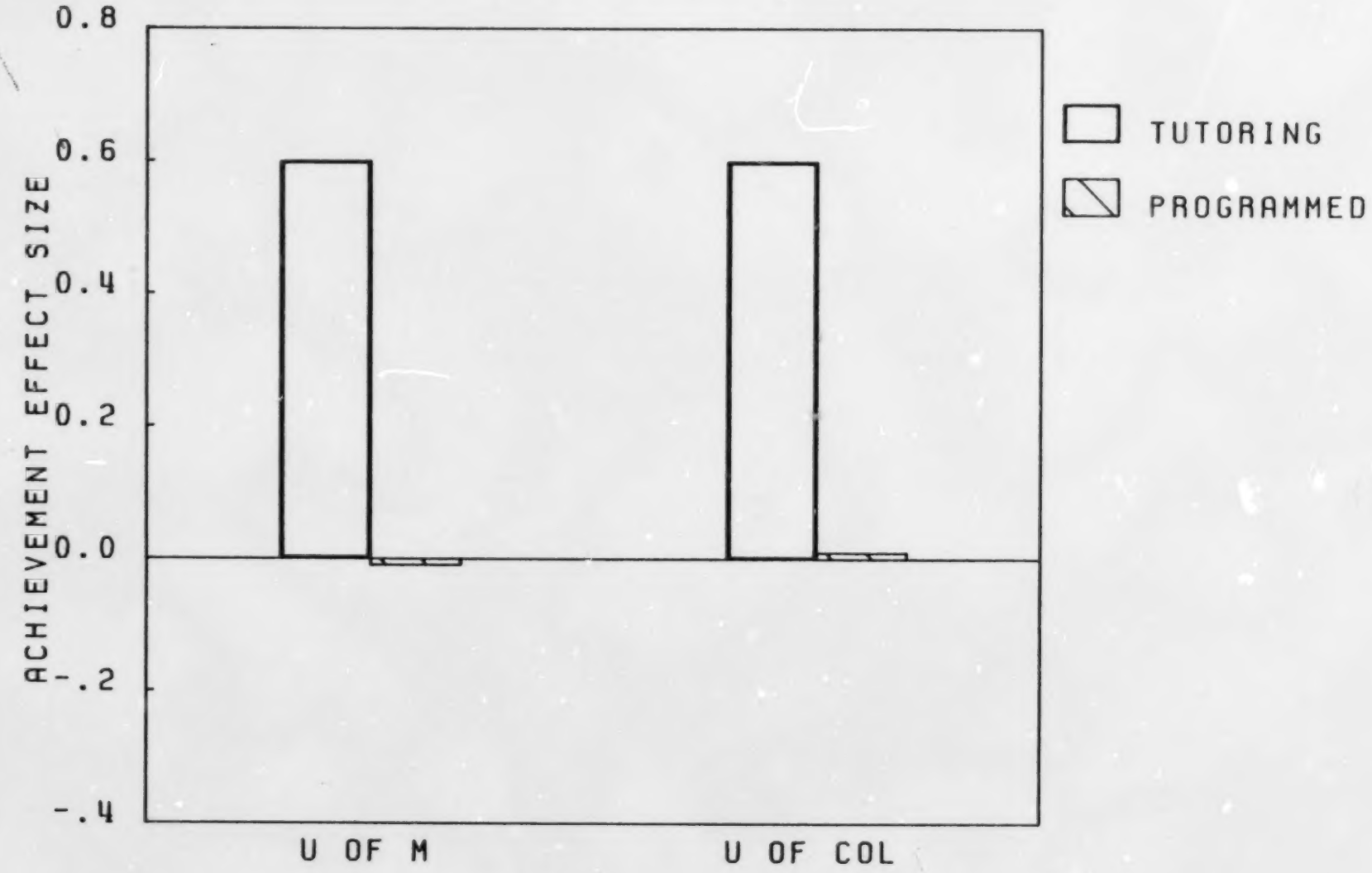
0.8
0.6
0.4
0.2
0.0
-.2
-.4
ACHIEVEMENT EFFECT SIZE
U OF M
U OF COL
TUTORING
PROGRAMMED

Figure 1

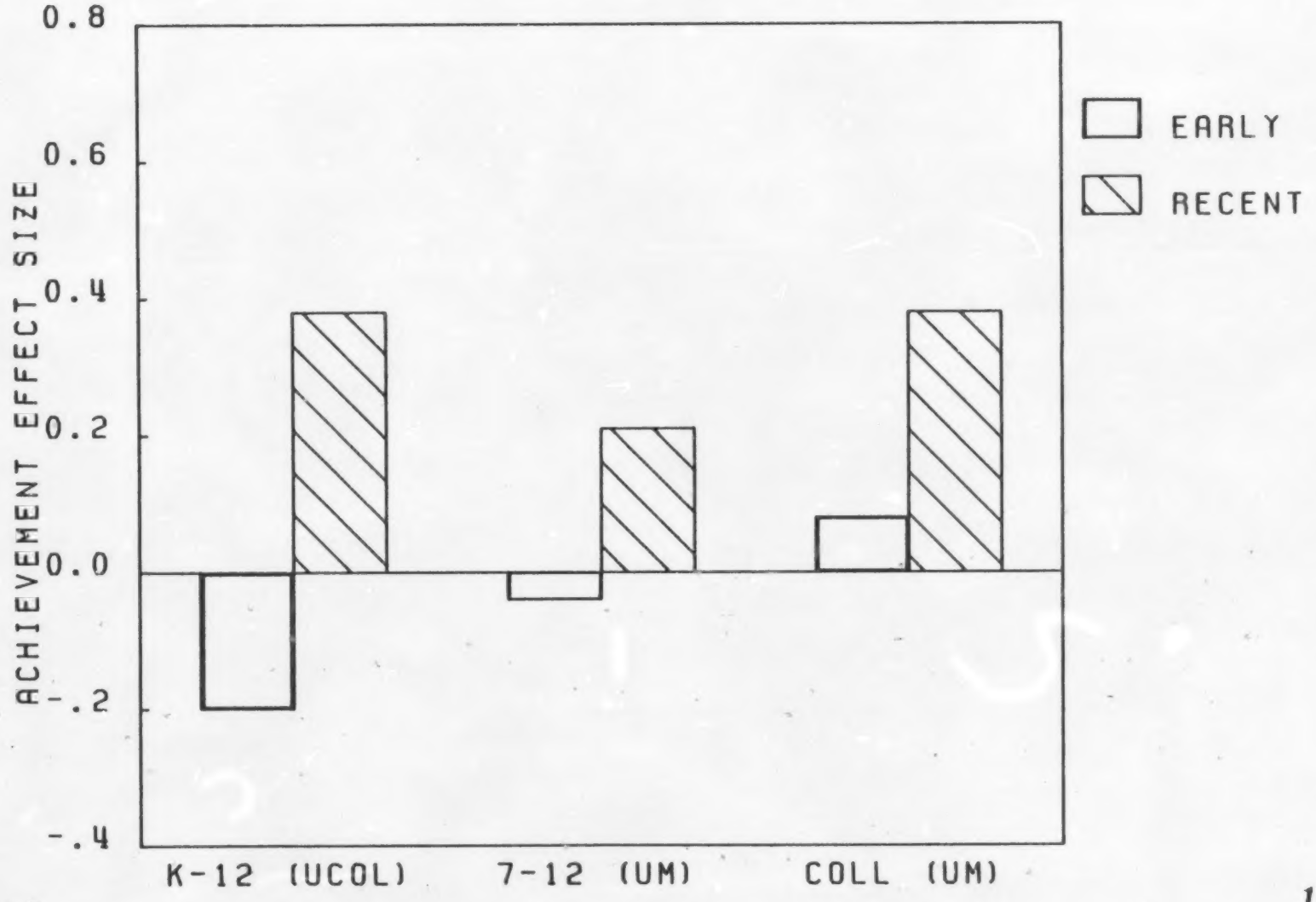
0.8
0.6
0.4
0.2
0.0
-.2
-.4
ACHIEVEMENT EFFECT SIZE
EARLY
RECENT
K-12 (UCOL)
7-12 (UM)
COLL (UM)

Figure 2

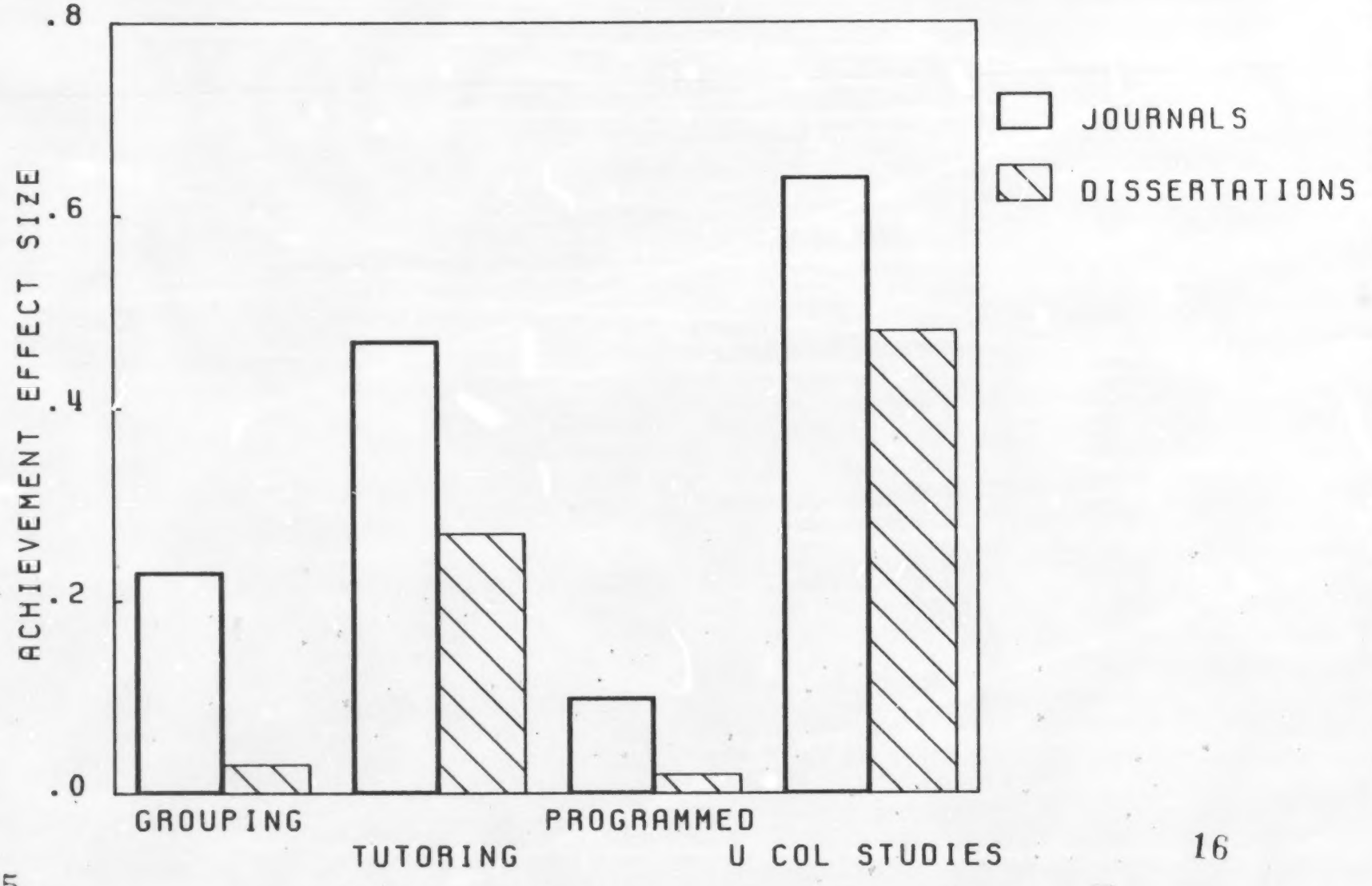
.8
.6
.4
.2
.0
ACHIEVEMENT EFFECT SIZE
JOURNALS
DISSERTATIONS
GROUPING
TUTORING
PROGRAMMED
U COL STUDIES

Figure 3

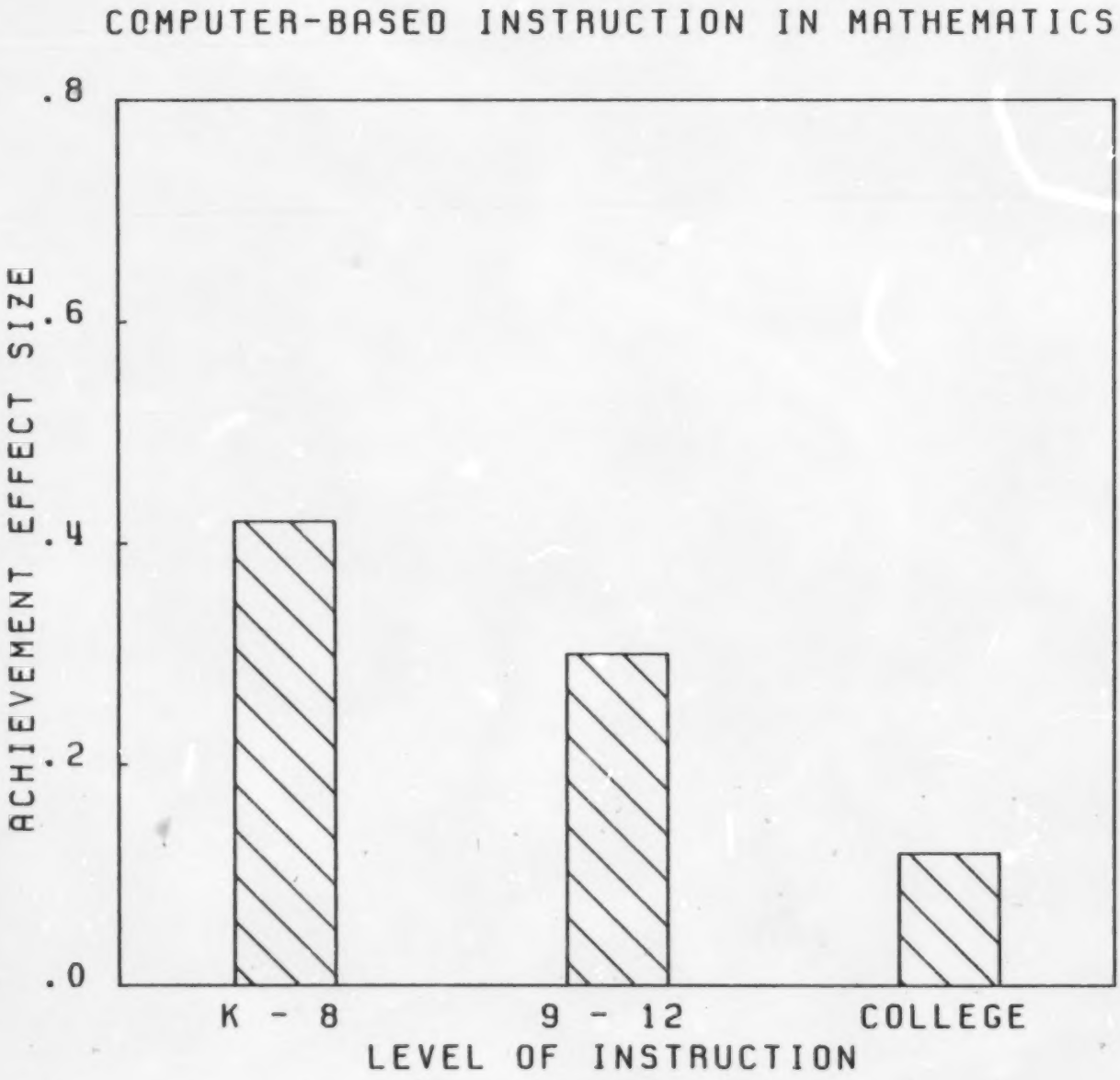
COMPUTER-BASED INSTRUCTION IN MATHEMATICS
ACHIEVEMENT EFFECT SIZE
.8
.6
.4
.2
.0
K - 8
9 - 12
COLLEGE
LEVEL OF INSTRUCTION

Figure 4

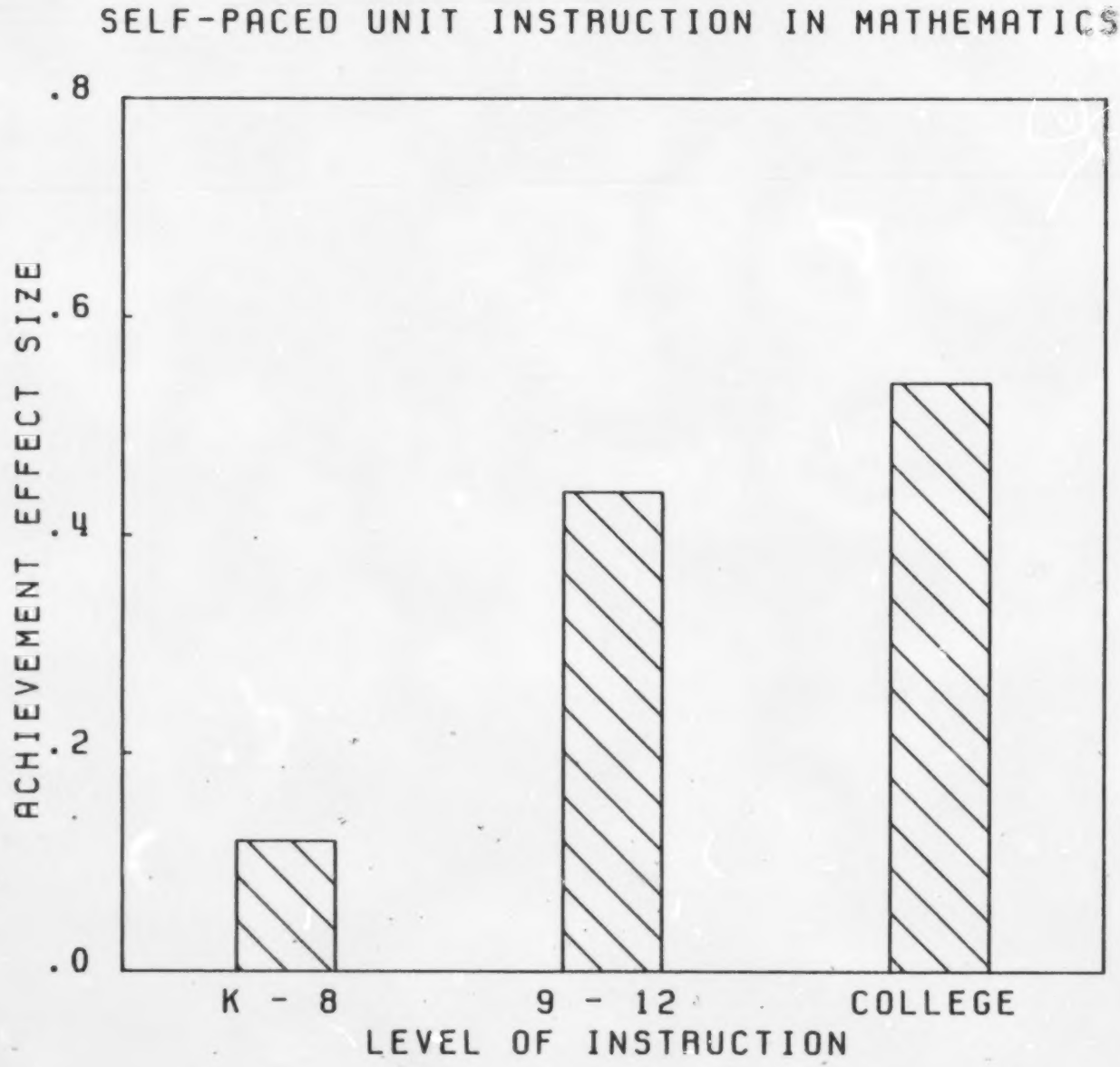
SELF-PACED UNIT INSTRUCTION IN MATHEMATICS
ACHIEVEMENT EFFECT SIZE
.8
.6
.4
.2
.0
K - 8
9 - 12
COLLEGE
LEVEL OF INSTRUCTION

Figure 5